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Does food security exist among farm households? Evidence from Ghana

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Abstract

Background: Food security exists when households have physical, social and economic access to sufficient, safe and nutritious food at all times that meets their dietary needs and food preferences for an active and healthy life. Food security remains a serious challenge for many households in Ghana and the situation is even more prevalent among smallholder farmers. Therefore, this study had its objectives to assess food security status and also estimate their determinants for policy recommendations.

Methodology: Using data collected from 2,603 farm households across Ghana and employing an ordered probit model the determinants of food security among farm households were assessed. The food security indicator, Food Consumption Score (FCS) which combines diet diversity, frequency of consumption and relative nutritional importance of different food groups was used to determine food security status of farm households.

Results: Results showed that farm households (76%) across Ghana were within the acceptable household food consumption groups. Nonetheless, 19% and 6% of farm households, respectively, were within the borderline and poor food consumption groups, respectively. Determinants of food security included experience, gender, improved variety adoption, access to credit and location.

Conclusion: Food security risk is prevalent among farm households in Ghana. Based on the results on determinants of food security, the suggestions are that government and private institutions should create an enabling environment to enhancing credit access and encouraging adoptions of improved crops varieties for increased production.

Keywords: Credit access, Food consumption score, Food security, Improved crop variety, Ordered probit model

JEL Classification: O13, Q12, Q16, Q18, Q55

Introduction

Household food security is an issue that affects populations around the world. According to FAO, IFAD, UNICEF, WFP and WHO [1], about 12 percent of the global population was severely food insecure in 2020, representing 928 million people, an increase of 148 million more than in 2019. It was estimated that 2.37 billion people in the world did not have access to adequate food in 2020 representing one in three people. FAO, IFAD, UNICEF, WFP and WHO [1] further stated that 2.37 billion people were facing moderate or severe food insecurity in the world. Out of the number 1.2 billion representing half were found in Asia, 799 million representing one-third were in Africa, and 267 million representing 11 percent were in Latin America and the Caribbean.

Similar to other African countries, Ghana is faced with the challenge of making significant improvement in food security. WFP [2] reported that 7.7%, and 0.8% of Ghanaians were moderately food insecure and severely food insecure,

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respectively. This is because 4.7% of its food needs is supplied by commercial food imports and food aid in the last 15 years [3]. It has been reported that about 5% of Ghana's population (1.2 million people) are food insecure [4]. FAO [5] asserts that 2 million of Ghana's population is vulnerable to become food insecure. Of this number 1.5 million live in rural and urban areas of these 7 regions of Ghana: Brong-Ahafo 11%, Ashanti 10%, Eastern 8%, Volta region 7%, etc. The remaining 0.5 million people are found in the three Northern regions (Northern, Upper East and Upper West Regions) [6]. Ghana has 49.1% of the total population being rural [7]. Apart from the Greater Accra and Ashanti regions that have 9.5% and 39.4% of the population being rural, all the other 8 regions(Eastern-56.6%, Western-57.6%, Central-52.9, BrongAhafo-55.5%, Volta-66.3%, Northern-69.7%, Upper East-79.0%, Upper West-83.7%) have rural population above 50% [7]. Majorities of these rural households, ranging from 31.3% in Greater Accra region to 93.7 in the upper East region are engaged in agricultural production. The implication is that many of the food insecure people are in the rural areas who ironically are involved in food production.

Agriculture in Ghana is mostly rain-fed, with less than one percent of cultivated land being irrigated [8]. Farmers in southern Ghana are therefore able to grow more food because they have two rainy seasons, while the north has only one. Farmers face challenges from climate change, low prices, poor road infrastructure, lack of access to finance, inadequate markets, post-harvest losses, insufficient education and knowledge, unsustainable farming systems, rural-to-urban migration, inappropriate policies and lack of technological change [9]. These have led to a reduction in farmers' incentives to invest and produce and ultimately have slowed the growth of agriculture in the country. Also, due to the poor traditional post-harvest management of food crops, 20–30 percent of the production is lost [10]. Losses of this scale lead to a food price increase, which in turn restricts access to food for households [10]. Farm households in Ghana experience significant level of food insecurity lasting from 3 to 7 months due to food shortages [11] depending on the location. Crop failure and seasonal difficulties in accessing enough food during lean seasons happen to be very common among these food insecure households [6]. Santeromo [12] opined that potential food losses occur both at production and at post-harvest stages, which constitute accidental reduction in the quantity and quality of food before consumption, aside food losses as a result of pests and diseases, limited harvesting techniques, price volatility, and inadequate production due to limited use of agricultural inputs. Food access may be curtailed as a result of food loss and food security may be undermined [13, 14].

Households in rural areas who are mostly farmers still experience food insecurity and hunger despite growing crops and even selling these crops in markets. Furthermore, evidence from several studies still point to increasing food insecurity and malnutrition issues at rural household levels [2, 15, 16]. For instance, a study by Kuwornu et al. [15], reports of 60 percent of farm households being food insecure in the central region of Ghana in a sample of 120 households that were interviewed. A recent study conducted by Armah et al. [17] find that in the rural farming community of the Bibiani Ahwiaso in the Western region of Ghana had 94 percent of the households faced with the threats of food insecurity in sample of 210 farming households in the study.

Though studies [4, 15–17] have been conducted on farm household's food security status in Ghana, a study that considered farm households across Ghana is hard to find. These studies are all case studies that are unrepresentative of the situation of food security among farm households in the whole of Ghana. The evidences that have been provided so far do not give grounds to adequate policy suggestions on Ghanaian farm households. This study fills the gap by using rich representative data collected on farm households across Ghana. This study sought to answer the following questions: 1. Do farm households across Ghana have food security risks? 2. What are the factors that determine food security among farm households across Ghana? The specific objectives were to evaluate food security situation and assess factors that determine food security of farm households across Ghana. The study would provide feedback information to policy regarding food security status of farm households in all ten regions of Ghana. This study used WFP's FCS which is a composite score that uses data from a 7-day dietary recall questionnaire that measures dietary diversity, food frequency and sourcing, and relative nutritional importance [18] as proxy measurement. None of the studies used FCS as proxy measure of food security. Derived from the Food and Nutrition Technical Assistance Dietary Diversity Score, the higher the score, the better the diet and the more food secure is the household [18].

Concepts and measurement of food security

FAO [19] defines food security as "a situation in which all people at all times have physical and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life". Despite the globally agreed upon definition of food security, it lacks a globally agreed upon measurability making it impossible to have a standardized measurement of what constitutes food security. Internationally

there is a broad agreement that food security has multiple dimensions including the availability, accessibility, utilization and stability [20]. Availability is the appropriate functioning of markets to ensure that foodstuffs have the ability to efficiently travel from the producers to the markets and from food-surplus areas to food-deficit areas [21]. However, in a broader food security context availability is more popularly defined as increasing production of food to create a larger global supply, rather than market functioning. A country's food availability is estimated by Food and Agriculture organization as the residual of the total quantity of foodstuffs produced and imported minus the total quantity exported, used for livestock feed and seed, put to manufacture for food and nonfood uses, and lost during storage and transportation [22].

Food accessibility is having sufficient resources (both economic and physical) to obtain appropriate foods for a nutritious diet. Access to food "concerns a household's ability to regularly acquire adequate numbers of food, through a combination of its own home production and stocks, purchases, barter, gifts, borrowing or food aid" WFP [20]. Food utilization "refers to households' use of the food to which they have access, and individuals' ability to absorb and metabolize the nutrients, i.e., the conversion efficiency of the body" FAO [23]. Food stability is the steadiness of availability, access and usage of food at all times without encountering risks [24].

Availability and access comprise several components: quantity (i.e., enough food and energy), quality (i.e., foods that provide all essential nutrients), safety (i.e., food that is free of contaminants and does not pose health risks), and cultural acceptability and preferences (i.e., foods that people like and that fit into traditional or preferred diets) [23, 25]. Leroy et al. [26] state that stability is a cross-cutting dimension which requires that available and accessible and utilization is adequate at all times. This takes into account external factors such as fluctuating food prices, national economic situations and climatic conditions. The National Research Council [27] of the United states incorporates experience and perceptions in its description of food insecurity and states that food insecurity is experienced by households and individuals when there is uncertainty about future food availability and access, insufficiency of the amount and kinds of foods (quality) required for a healthy lifestyle, or the need to use socially unacceptable ways to acquire food.

From the foregoing, Food security is multidimensional and thus presents a variety of measurements. Several indicators have been developed as proxies for food security. The most direct measurement of household-level food security that captures caloric and nutritional intake is either anthropometry measurements or detailed, multi-visit household expenditure or dietary recall logs [28]. But acquiring accurate data through such methods is time-intensive, invasive, and expensive. Instead, household food security can be more generally assessed via proxy metrics derived from: (1) single-visit dietary recall; (2) coping strategies; and (3) psychosocial and physical experience of food insecurity [29]. These measures developed and validated by the World Food Programme (WFP) and other organizations include Coping Strategies Index (CSI), Reduced Coping Strategies Index (rCSI), Household Food Insecurity and Access Scale (HFIAS), the Household Hunger Scale (HHS), Food Consumption Score (FCS), Household Dietary Diversity Scale (HDDS) and a self-assessed measure of food security (SAFS) [30]. Nonetheless, Santeromo [31] opined that the existing indicators are not comparable, as they convey different information on food security. Santeromo [31] further argues that they failed to capture psychological factors such as anxiety, worries, which are fundamental determinants of food insecurity. Composite indicators such as the Global Food Security Index, the Global Hunger Index, and Poverty and Hunger Index have therefore been proposed to measure food security. However the concern is on choice of algorithms to compute composite indexes for food security and thus Santeromo [31] suggests attention to be paid to the choice of data imputation and aggregation methods.

A comprehensive all-encompassing measure of food security would be that measure that is valid and reliable, comparable over time and space, and which captures different elements of food security [30]. Nevertheless, the complexity of food security, as a cross-cutting discipline, has engrossed the challenge to finding a summative (or 'gold standard') measure of household food insecurity [32]. FANTA [33] includes 33 indicators in its recommended list of indicators for measuring food insecurity access alone. Upton et al. [34] propose a development resilience measurement that offers a potential solution to satisfy these unmet food security measurement needs. The strategy measures food security that incorporates all axioms suggested by FAO [19]. They define development resilience as "the capacity over time of a person [or] household… to avoid poverty in the face of various stressors and in the wake of myriad shocks Upton et al. [34]. However, the approach allows Type I or Type II error, depending on operational preferences. Chung et al. [35] asserted that the need to finding a simple and realistic measure of household food insecurity that can be labeled as "golden rule" combining rigor and statistical efficiency to conclude food insecurity from the household level upwards is important.

FAO and the World Food Programme (WFP) use information on dietary diversity as one element to analyze food security. However, the organizations use different data collection methods and analytical strategies [18, 36]. The FAO uses a 1 day household dietary diversity score (HDDS) based on guidelines produced by the Food and Nutrition Technical Assistance Project [5] and the WFP uses a food consumption score (FCS). Both the HDDS and the FCS have been validated in different countries as proxy measures of household per capita energy intake [37].The tools are both used for monitoring and surveillance of household economic access to food [20] and in both methods collected data can also be used to identify dietary patterns and consumption of specific foods. Information obtained from either measure is most useful for application within a given country or similar agro-ecological zone, rather than across countries and regions which have diverse dietary patterns. This study adopts the WFP's FCS to measure food security status of farm households across Ghana.

This indicator of food security was used because it can accurately capture dietary diversity which is usually highly correlated with such factors as caloric and protein adequacy, percentage of protein from animal sources (high quality protein), and household income [32]. Also it was inexpensive to collect the data for the analysis of FCS of farm households as data could be captured on a single visit based on list of available food items. Though FCS has not been validated for nutrient adequacy [30], it can be associated with caloric intake [32] which is key indicator of food security.

Materials and methods

The study area

Data for this study were collected from farm households across Ghana. The study was conducted when Ghana had ten regions. Figure 1 shows the study area. All ten regions (Ashanti, Brong Ahafo, Central, Eastern, Greater Accra, Northern, Upper East, Upper West, Volta and Western regions) of the country were surveyed from August 2016 to February 2017.

Ashanti, Brong Ahafo, and Eastern regions, which are mainly transitional and deciduous forest areas producing constitute 19.4%, 9.64%, and 10.7% of the national population, respectively [7]. The share of agricultural activities is also high in these regions: Ashanti (36.6%), Brong Ahafo (68.5%), and Eastern (59.2%) [7]. Western region falls within the Evergreen and Deciduous Forest zones. Its share of the agricultural activities is 49.80%. The Volta region cuts across three agro-ecological (coastal, deciduous forest, and savannah) zones. It constitutes 8.6% of the population and is made up of subsistence agriculture of which 58.8% of are engaged in agriculture and fishing. Central region, primarily deciduous forest and coastal and constitutes 8.9% of the population. 51.40% of the population is engaged in fishing and agriculture as the main economic activities Ministry of Food and Agriculture [8]. The three northern regions (Upper West, Upper East, and Northern), fall within Savannah agro-ecological zone. These three regions constitute 17.1% of Ghana's population [7]. Over three quarters of households in these regions (Upper West (77.1%), Upper East (83.7%), and Northern (75.5%)) are engaged in subsistence agriculture [8].

The mean annual temperature varies from 26.1 °C at the southwest coast of Western region to 28.9 °C at the northeast border of the Upper East, but can reach up to 40 °C in the northeast [8]. Mean annual rainfall varies from approximately 1000 mm in the northeast border of the Upper East region to 2200 mm in the southwest coast of Western region. The coastal zone is an arid area experiencing only mean annual rainfall of 800 mm [8]. The three northern regions, with the highest dependence on subsistence agriculture, experience annual average rainfall of approximately 1,000 mm. Brong Ahafo, Ashanti, Eastern, Central, and Volta regions, also with high dependence of subsistence agriculture, experience a mean annual rainfall of 800 mm to 1500 mm and mean annual temperatures of 26.4 °C [8].

Sampling, data and data collection

A multi-stage sampling technique was employed to select districts and villages. Cluster sampling method was used to select Districts based on staple food production levels. Afterwards, farm households were randomly selected from Enumeration Areas (EAs) within the selected villages. EA's contain the same number of persons [39]. EAs were used for the proportional sampling of farm households. Enumeration areas (EAs) were obtained from the Ghana Statistical Service. Crops producing districts were collected from regional and district directorate of Ministry of Food and Agriculture. In each district, 4 EAs were selected and 7 farm households were contacted. Thus a total of 396 EAs from 99 districts across Ghana were visited. On the whole 2772 farm households were contacted across the country. However due to incomplete information 169 were discarded and data on 2603 households were utilized.

The selected households were interviewed face to face with structured questionnaires, which were carefully designed and pre-tested. In addition to farm and farmer data, data on various food items were collected. The household-level dietary section of the questionnaire was answered by the person responsible for food preparation in the household. Food consumption at the household level was captured through a 7-day recall recommended by WFP (18). Data were collected from the list of food items available in the country. Respondents

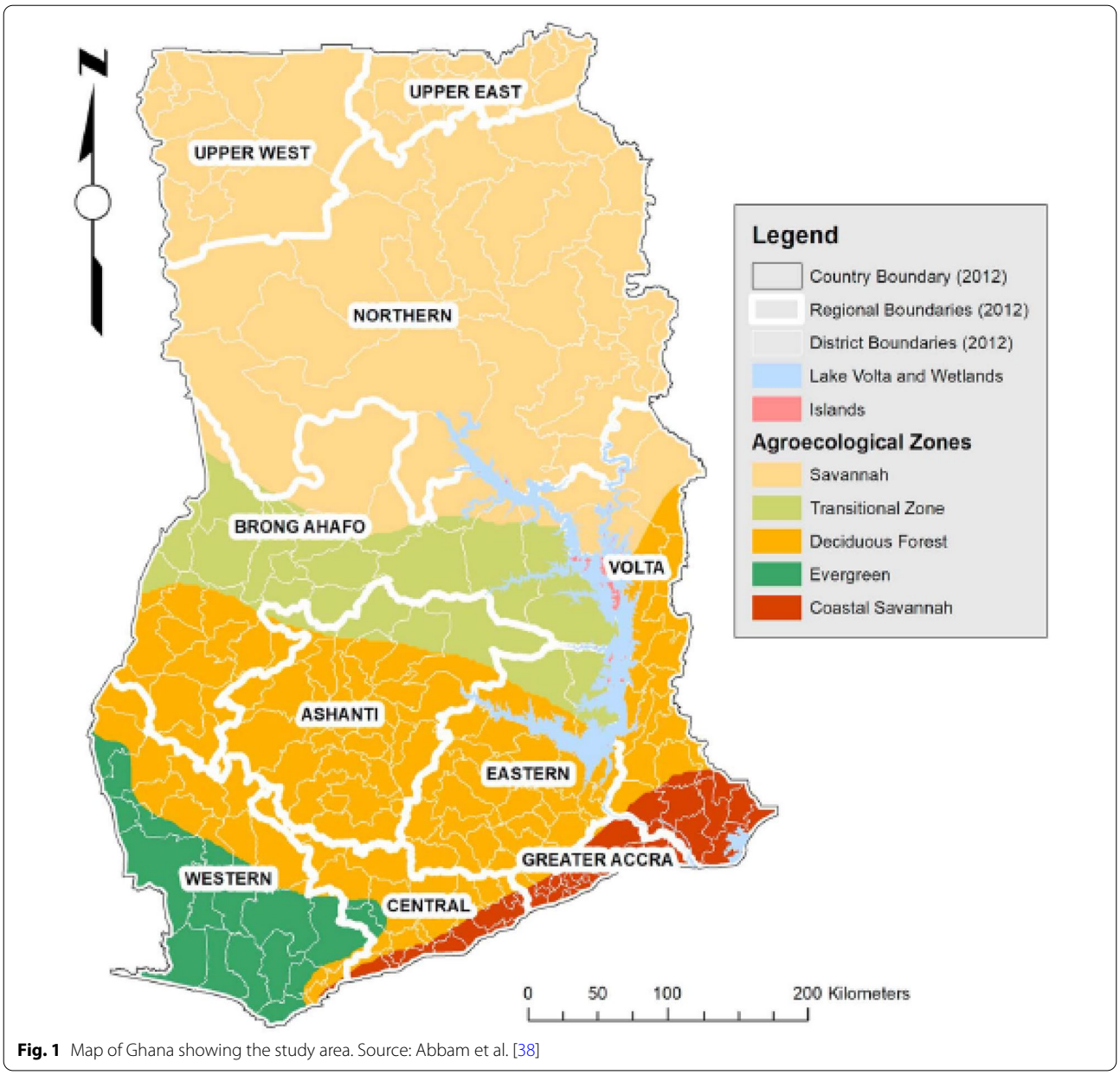

Fig. 1 Map of Ghana showing the study area. Source: Abbam et al. [38]

were asked about frequency of consumption of specific food items (in days) over a recall period of the past 7 days.

Measurement of household food consumption score (HFCS)

The HFCS is a 7-day quantitative aspect of food frequency or consumption pattern by World Food Programme. The HFCS is a frequency-weighted HDDS [18]. The HFCS is an indicator of dietary diversity and frequency of consumption, which is based on a food consumption record of the previous seven days' food consumption. It is computed using the consumption frequency of eight differing food groups: "main staples, pulses, vegetables, fruit, meat and fish, milk, sugar and oil" [40].The consumption frequency of each food group was multiplied by an assigned weight (see Table 1) that is based on its nutrient content. Those values were then summed up obtaining the Food Consumption Score (FCS). Following WFP [18], FCS was then classified into three categories: poor consumption (FCS = 1 to 28); borderline (FCS = 28.5 to 42); and acceptable consumption (FCS = > 42).

Table 1 Food items, food group and weight

No.	Food groups	Weight
1	Cereals (bread, rice, maize, barley) and tubers (potatoes, sweet potatoes)	2
2	Pulses and nuts (beans, lentils, peas, peanuts, etc.)	3
3	Vegetables	1
4	Fruits	1
5	Meat and fish (all types)	4
6	Dairy products (milk, yoghurt, cheese, other milk's products)	4
7	Sugar, honey	0.5
8	Oil, fat, butter	0.5

Source: WFP [18]

Empirical model

An ordered probit model was used due to the ordinal nature of the dependent variable. The dependent variable was FCS which was categorical and had 0 = poor; 1 = borderline and 2 = acceptable which indicated the food security status of farm households. Green [41] opined that granting that the outcome is discrete, the multinomial logit or probit models would fail to account for the ordinal nature of the dependent variable. Whereas the logit assumes a logistic distribution of the error term, the probit assumes a normal distribution [42]. According to Chung et al. [35] the logistic and normal distributions generally give similar results usually. Moreover, Davidson and MacKinnon [43] point out that the ordered probit is the most used model for ordered response data. Following Johnston et al. [42], an ordered probit model is written as:

$$z_j^* = X_j\beta + \varepsilon_j; 1 \le j \le n, \tag{1}$$

where z_j is a continuous, latent variable, X_j is a $1 \times k$ vector of explanatory variables, β is a $k \times 1$ vector of unknown parameters, and the ε_j is assumed to be independently and identically distributed with a probability density function (pdf) denoted $f(\varepsilon, \theta)$, with distributional parameters θ. The above model could be consistently estimated using ordinary least square (OLS) if z_j. was observed and $E\varepsilon_j|X_j = 0, \forall j$ [36]. Due to the discrete-choice nature of the data, OLS will result in heteroskedastic errors and predicted probabilities that may fall outside e range of (0, 1) for each outcome described. As a result of this problem, the maximum likelihood estimation is often used to estimate the unknown parameters. Consider the observed variable z_j:

$$z_j = \begin{cases} 0\, if z_j^* < \gamma_1 \\ 1\, if\, \gamma_1 \le z_j^* < \gamma_2 \\ 3\, if\, \gamma_2 \le z_j^* < \gamma_3 \end{cases}. \tag{2}$$

The probability of observing a particular outcome, for $1 \le j \le i$. is given by:

$$\begin{aligned} \mathrm{P}(z_j = i|X_j) &= \mathrm{P}\left(\gamma_{i-1} \le z_j^* \le \gamma_i\right) \\ &= \mathrm{P}(\gamma_{i-1} - X_j\beta \le \varepsilon_j \le \gamma_i - X_j\beta) \\ &= F(\gamma_i - X_j\beta; \theta) - F(\gamma_{i-1} - X_j\beta; \theta), \end{aligned} \tag{3}$$

where F is the cumulative distribution function for ε_j, $\gamma_0 = \gamma_{I-1} = -\infty$, and $\gamma_i = \infty$. The presence of F leads to a maximum likelihood estimation framework written as:

$$\log L = \sum_{j=1}^{n} . \sum_{i=1}^{3} z_{ji} \log\left[F(\gamma_i - X_j\beta; \theta) - F(\gamma_{i-1} - X_j\beta; \theta)\right] \tag{4}$$

This log-likelihood function is maximized with respect to β, θ and the cut points $\gamma_1 < \gamma_2$. In the case of two discrete outcomes, the log-likelihood function in Eq. (4) simplifies to the binary choice model with one cut point which is normally set to be 0 to achieve identification of the intercept term [42].

Green [41], pointed out that since there is no meaningful conditional mean function and the marginal effects in the ordered probability models are not straightforward, the effects of changes in the explanatory variables on cell probabilities are normally considered. These are given by:

$$\frac{\partial Prob[z = i|X_j]}{\partial X_j} = \left[F'(\gamma_{i-1} - X_j\beta) - F'(\gamma_i - X_j\beta)\right]\beta. \tag{5}$$

Consequently, the empirical model of this study is specified as:

$$FCS_{ji} = \alpha + \beta W_j + \gamma X_j + \delta Z_j + \varepsilon_j, \tag{6}$$

where *FCS* is food consumption score used as food security proxy; j represents a household, i ($i = 0, 1, 2$) represents the three categories of alternative dependent

ordered variables indicating (i) whether a household falls within poor food consumption group category; (ii) whether a household falls within borderline food consumption category, and (iii) whether a household is within the acceptable food consumption category group. W, X and Z are, respectively, socioeconomic, food production, institutional and location characteristics hypothesized to influence food security (Table 2); $\beta, \gamma, \alpha, \delta$ are parameters to be estimated.

Generally, results showed that the respondents were dominated by males and they constituted about 77%. In most Ghanaian cultures especially in the Northern part, the customary laws do not permit women to own land [44], though both men and women undertake agricultural activities. However, most females in the southern part own land as a result of matrilineal system of inheritance. The influence of Gender on food security is mixed as both male-headed and female headed farm households can be food secure. Majorities (88%) were married and were mostly natives from their respective locations. Marital status is expected to influence food security positively [45, 46]. On level of education, about 41% of the respondents had no formal education, about 30% had up to Junior High School (JHS)level of education and 27% had up to Senior High School(SHS) level of education. Ghana Statistical Service [47] found out that farm households in rural areas were mostly illiterates in their National census conducted on farm households in Ghana. Education is expected to influence food security positively. Average age of a respondent was 47 years. The influence of age on farm household food security cannot be predetermined as both the aged and the youth can produce more or make purchases from the market.

Table 2 Description, measurement, hypothesis and summary statistics of variables used in the model

Variable description	Measurement	Hypothesis	Percent	Mean	Std. deviation
Gender of head of household (GN)	Dummy; 1 if male, 0 otherwise	+−	76.91		
Age of farm household head(AGE)	Years of farm household head	+−		46.83	16.01
Years of formal education of farm household head(EDUYRS)	Number of Years a farm household head has spent in school	+		6.15	5.88
Household members of farm household (HSIZE)	Number of persons in a household	+−		7.83	4.21
Farming experience of farm household (FEXP)	Number of years a farm household head has spent in crop production	+−		22.95	12.47
Farm household head growing improved crop varieties(HGWIMP)	Dummy: 1 if yes, 0 otherwise	+	39.03		
Farm household total crop income(HINCOME))	Ghana cedi	+		4799.53	5519.66
Marital status (MAR)	Dummy; 1 if married, 0 otherwise	+	87.67		
Resident status (RSTA)	Dummy; 1 if resident, 0 otherwise	+	71.80		
Membership in Association (ASSM)	Dummy; 1 if yes, 0 otherwise	+	60.05		
Farm household head able to contact extension staff (EXTACC)	Dummy; 1 yes, 0 otherwise	+	79.10		
Farm household head able to receive credit(CRDACC)	Dummy; 1 yes, 0 otherwise	+	49.90		
No formal education(NEDU)	Dummy; 1 if yes, 0 otherwise	−	40.03		
Up to Primary 6	Dummy; 1 if yes, 0 otherwise	+−	2.03		
Up to Junior High School(JHS)	Dummy; 1 if yes, 0 otherwise	+	28.01		
Up to Senior High School(SHS)	Dummy; 1 if yes, 0 otherwise	+	27.20		
Tertiary (excluding university) (TEXUNI)	Dummy; 1 if yes, 0 otherwise	+	2.04		
Tertiary (University) (TEUNI)	Dummy; 1 yes, 0 otherwise	+	0.69		
Region of farm household head (REG_Ashanti)	Dummy; 1if Ashanti, 0 otherwise	+	13.25		
Region of farm household head (REG_Brong Ahafo)	Dummy; 1 if Brong Ahafo, 0 otherwise	+	18.82		
Region of farm household head (REG_Central)	Dummy; 1 if Central, 0 otherwise	−	10.80		
Region of farm household head (REG_Eastern)	Dummy; 1 if Eastern, 0 otherwise	+	13.52		
Region of farm household(REG_Greater Accra)	Dummy; 1 if Greater Accra, 0 otherwise	−	3.23		
Region of farm household head (REG_Northern)	Dummy; 1 if Northern, 0 otherwise	−	11.49		
Region of farm household head(REG_Upper East)	Dummy; 1 if Upper East, 0 otherwise	−	7.53		
Region of farm household head(REG_Upper West)	Dummy; 1 if Upper West, 0 otherwise	−	4.73		
Region of farm household(REG_Volta)	Dummy; 1 if Volta, 0 otherwise	+−	13.48		
Region of farm household head(REG_Western)	Dummy; 1 if Western, 0 otherwise	−	3.15		

The average household size was about 8 persons, higher than national average of 5 [47]. The influence of household size on food security cannot be predetermined as large household size may add more pressure on household in terms of the number of people required to feed [48]. On the contrary, household size may mean the availability of family labor for other off farm activities that may increase incomes boosting food security situation of a household [49]. About 50% of the respondents had access to credit and 79% reported that they had access to extension. Access to institutional factors is very important to increasing production of farm produce and thus increasing food access. Credit may increase the probability of a household's ability to procuring production inputs as seeds, chemicals, and hiring of labor [50], which could improve production and thus the household food situation. Access to credit by households was therefore predicted to positively correlate with household food security status. About 39% of farm households had adopted any improved crop varieties. Adoptions improve crop productivity and thus are expected to improve household food security. Location is also an important predictor of household food security as it is conditioned with climate variability. Depending on whether a household is located in an ecological zone that falls in stable climatic conditions will determine the amount of produce and thus affect food security. The regions located in forest and forest transition zones are expected to have farm households who are food secure due to favorable climate. Farmers located in Coastal savannah and Guinea Savannah zones are expected to be somewhat food secure due to unfavorable weather conditions.

Results and discussion

Farm household's dietary diversity

Figures 2 and 3 show that cereals and root crops and vegetables were consumed every day by 96% and 91%, respectively, in the 7-day recall period. Ghanaian food system consists largely of cereals and root crops and

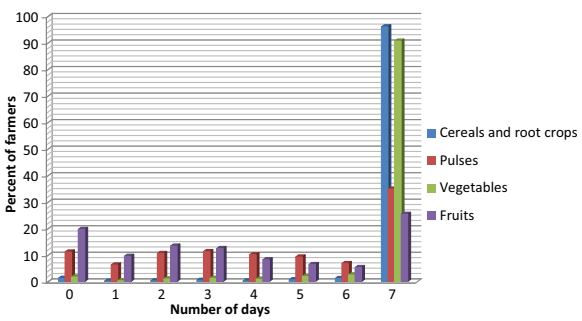

Fig. 2 Consumption of cereals and root crops, pulses, vegetable and fruits food groups

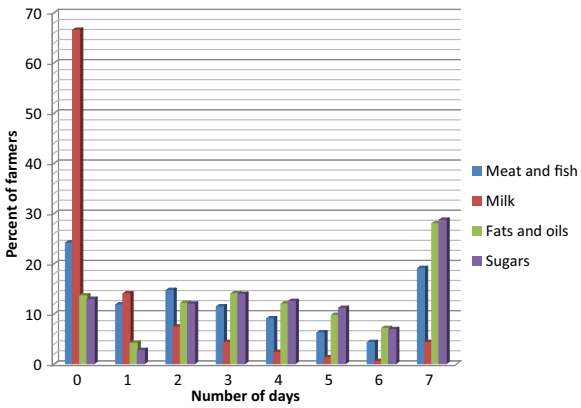

Fig. 3 Consumption of meat and fish, milk, fats and oils, and sugars

local vegetables which are part of everyday culinary prepared in homes in both rural and urban areas. Data from Ministry of Food and Agriculture [8] noted that Ghanaians have the tradition of eating cereals and root and tuber crops. The results also showed that consumption of pulses (cowpea, groundnut, beans) and fruits were not as common as roots and tubers and cereals. However, about 35% and 25% of the respondents consumed pulses and fruits, respectively, every day during the 7-day recall period. Per capita consumption of these crops is low in Ghana [8].

Figure 3 reveals that 66% of the respondents did not consume milk at all over the 7-day recall period and 24% had no meat or fish during the same period. According to Codjoe et al. [51] most Ghanaians have high dietary diversity, but have low consumption of foods rich in micronutrients such as fruits and milk/dairy products. Respondents also participated in fats and sugars to a certain level during the recall period. Nonetheless, if households did not produce a food item, the frequency of consumption decreased. Ecker [52] found similar results in their study of Agricultural transformation and food and nutrition security in Ghana where households consumed own produce frequently compared with purchased food items.

Farm household's food consumption score

Figure 4 shows that majority (76%) of farm households across the country were within the acceptable HFCS.

Majority of farm households in each of the regions had acceptable HFCS. Although there was substantial numbers (19%) of farm households on borderline HFCS across the regions, Northern, Western, Upper East and Upper West regions had 22.1%, 22%, 21.40% and 21.1% of members, respectively, on borderline HFCS higher than the rest of the regions. Based on World Food

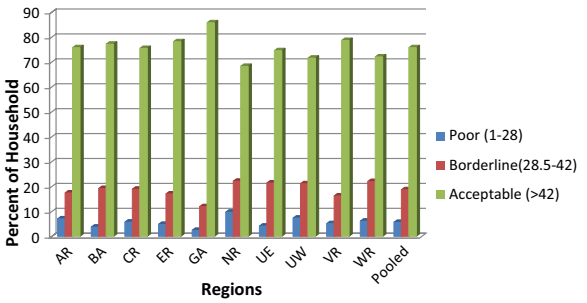

Fig. 4 Distributions of farm household food consumption score by region. Note: AR is Ashanti Region; BA is Bono Ahafo region; CR is Central Region; ER is Eastern Region; GA is Greater Accra Region; NR is Northern Region; UE is Upper East region; UW is Upper West Region; VR is Volta Region; WR is Western Region

Programme's classification these regions have quite a number of farm households who are moderately food secure [6]. Northern, Upper East and Upper West regions have unfavorable climate in terms of rainfall and temperature. They have one season of rainfall and scorching temperatures which are not the case in the rest of the country. Some farmers from that part of Ghana may not have the luxury to produce diverse crops that contribute to food security. Mustapha et al. [53] stated that households that cultivate at least three different types of crops have better food consumption score than those that only cultivate one type in the Northern part of Ghana in their study of food security situation in the region. The Western region is known for the production of cash crops at the expense of food crops and thus the result was not surprising. Armah et al. [17] find 94% of farm households in Bibiani in Western region having threats of food security. Generally about 6% of the respondents across the country were found within the poor food consumption group. Darfour and Rosentrater [4] reported that about 5% of Ghana's population was severely food insecure, a result which corroborates with results from this study.

Determinants of food security among farm households

Table 3 presents results of determinants of food security among farm households in Ghana. Results revealed that experience in farming decreased the probability of falling into the poor and borderline food consumption groups but increased the probability of falling into the acceptable food group. The possible explanation is that farmers with years of experience may have larger farm holdings and may also be practicing mixed farming thus making it possible to access all food groups with ease. Oluyole et al. [54] found a positive relationship between farming experience and food security status in their study of food security status among farm households in Nigeria. Our results showed that Up to JHS level of education decreased the probability of falling within the poor and borderline food consumption group but increased the likely of being found in the acceptable food consumption group. Some level of education is important in ensuring diversity of food consumption in farm household. Similar result was obtained by Ngema et al. [55] in their study of Household Food Security Status and Its Determinants in Maphumulo Local Municipality, South Africa where education positively influenced the food security status of households.

We found that male-headed farm households were more likely to be poorly food secured (poor food group) and moderately food secured (borderline food group). Nonetheless, female headed farm households were more likely to be highly food secured (acceptable food group). While the result is counter-intuitive it is somewhat true that female headed households mostly produce food crops that are mainly eaten by the household [56]. Women are also responsible for selection, planning and preparation of food and mostly allocate household incomes to food purchases [57] which may be reason for being more food secured.

Our results discovered that growing of improved varieties decreased the probability of being found in poor and borderline food consumption but increase the probability of being in the acceptable food consumption group. Improved varieties are high yielding and those that produce them are likely to have enough for the household and also for sale to be able to purchase other food items. Qaim [58] found out in his study of Agrifood Systems and Sustainable Nutrition that adoption of modern crop varieties increases yields and thus increases food availability and also improves agricultural profits and incomes of smallholder farmers.

Access to credit was associated positively with farm household food security, both severe and moderate but was negatively associated with acceptable food group. It is implied that farmers that have access to credit may use it for purposes other than farming. They may also not use credit for purchase of food items. Perhaps farmers sought credit for children's school fees, clothing, seeking health care, etc. Aidoo et al. [59] found significant positive relationship of credit access on household food security. Their result is in contrast with the results of this study. However Mustapha et al. [53] found similar results on farm households in Northern Ghana where credit access significantly increased food insecurity of farm households. Ngema et al. [55] found credit access negatively influenced the food security status of households corroborating with this study result.

As regards location, our results showed that farm household food security is associated with all regions

Table 3 Ordered probit estimates of determinants of food security of farm households in Ghana

Variables	Estimates		Marginal effects					
	Coeff	Std error	Y = 0	SE	Y = 1	SE	Y = 2	SE
Gender	− 0.162*	0.090	0.018*	0.010	0.025*	0.014	− 0.044*	0.024
Age	− 0.203	0.056	0.023	0.015	0.032	0.021	− 0.055	0.037
Household size	0.001	0.007	0.000	0.0008	0.0002	0.001	0.003	0.001
Farming Experience	0.004*	0.002	− 0.004*	0.002	− 0.006*	0.0003	0.001*	0.0006
Growing improved variety	0.158***	0.055	− 0.018***	0.006	− 0.025***	0.008	0.043***	0.015
Household total crop income	2.77e− 06	4.96e− 06	− 3.21e−07	5.74e− 07	− 4.38e−07	7.85e− 07	7.59e−07	1.36e−06
Marital status	− 0.042	0.122	0.004	0.013	0.006	0.019	− 0.010	0.032
Residence status	0.087	0.064	− 0.010	0.007	− 0.013	0.010	0.024	0.017
Association membership	0.017	0.056	− 0.002	0.006	− 0.003	0.009	0.005	0.015
Extension access	0.013	0.068	− 0.005	0.007	− 0.002	0.010	0.004	0.018
Credit access	− 0.123**	0.064	0.014**	0.007	0.02**	0.010	− 0.034**	0.017
Head of household	− 0.050	0.089	0.006	0.010	0.008	0.014	− 0.014	0.026
up to primary 6	0.619***	0.075	− 0.061***	0.007	− 0.098***	0.011	0.159***	0.018
up to junior high school level	4.771	619.785	− 0.963***	0.008	− 0.212***	0.050	0.308***	0.053
Up to senior high school level	0.143**	0.070	− 0.019**	0.009	− 0.023**	0.011	0.042**	0.020
Tertiary excluding university	0.067	0.180	− 0.09	0.024	− 0.011	0.030	0.020	0.054
University	0.343	0.341	− 0.024	0.032	− 0.056	0.054	0.097	0.086
Ashanti Region	0.036	0.167	− 0.004	0.019	− 0.005	0.026	0.010	0.045
Brong Ahafo Region	− 0.099	0.097	0.006	0.006	0.009	0.009	− 0.016	0.015
Central Region	− 1.151***	0.119	0.138***	0.017	0.093***	0.009	− 0.231***	0.023
Eastern Region	0.093	0.106	− 0.005	0.006	− 0.008	0.010	0.014	0.016
Greater Accra Region	− 1.529***	0.188	0.212***	0.036	0.105***	0.009	− 0.317***	0.040
Northern Region	− 2.612***	0.115	0.453***	0.201	0.104***	0.009	− 0.557***	0.020
Upper East Region	− 2.420***	0.157	0.410***	0.030	0.106***	0.009	− 0.516***	0.028
Upper West Region	− 2.511***	0.156	0.430***	0.030	0.105***	0.009	− 0.53***	0.029
Volta Region	− 1.204***	0.112	0.148***	0.016	0.095***	0.008	− 0.243***	0.021
μ_1	0.757	0.187						
μ_2	1.683	0.184						
N	2603							
Log likelihood	− 1967.530							
Wald X^2	2145.07***							

***, **,*, represent significance at 1%, 5% and 10%, respectively; μ1 and μ2 are threshold parameters in ordered probit model

except Ashanti, Bono Ahafo and Eastern regions. The results revealed that farm households in Central, Greater Accra, Northern, Upper East, Upper West and Volta were more likely to be severely and moderately food insecure. This is not surprising as these regions fall within the coastal savannah and savannah agro-ecological zones where weather conditions are not always favorable. Farmers may not produce enough in those areas for consumption and for sale to purchase diverse food items. Armah et al. [60] opined that food security is a challenge in the Savannah agro-ecological zones due to decreases in rainfall and increases in temperature. The authors pointed to projected drier climate conditions due to decreases in rainfall and increases in temperature for Guinea and Savannah agro-ecological zones of Northern Ghana that may further decrease suitable croplands for cultivation. Prevalence of food security risks among households in Central and Greater Accra regions are reported by Kuwornu et al. [12] and Codjoe et al. [51] corroborating this studies results.

Conclusions and implications

The study had its main objectives to assessing farm household's food security status and evaluating factors determining food security. The assessment of Dietary Diversity showed that farm households' diet consisted mainly of cereals and root tubers and vegetables. Dairy products were the least consumed. Food security status

proxy by Food consumption score revealed that majority of farm households are within the acceptable food consumption group. However, the number that falls within poor (6%) to borderline (19%) food consumption group is substantial (25%) and very worrying. The odds of being food secure by farm households were determined by factors that include, experience, education level, and improved variety cultivation.. These factors were found to be significant in improving the household food security status, but for gender, access to credit, and location which were found to be negatively correlated with the food security status of households in Ghana.

These findings highlight the importance of experience, education and improved varieties in food security intervention initiatives in boosting household food security status. Education is important in determining food security status of farm households. Education helps the members within a household to be aware of the available means and options of new practices of farming, such as use of improved varieties and good agronomic practice that have the propensity to increase productivity of households and thus their food security status. The ability to sell more farm produce to purchase other food items will increase due to more output produced and that could increase the supply of diverse food items.

The importance of using agricultural technology such as improved crop varieties is highlighted by the findings from the study. The use of high yielding crop varieties increases home supply and increases sale of produce for purchase of other food options. Government and private sector efforts to making availability and accessibility of improved varieties released by National Research Institutions will help curb food security risk due to their high productivity and disease and pest tolerance.

The findings of the study also highlight the vulnerability of rain-fed agriculture. The results showed that regions that fall within Coastal and Guinea Savannah agro-ecological zones were unlikely to fall within the acceptable food security group but more likely to fall within the poor to moderate food consumption group. These zones experience single rainy season which is erratic and thus affect food production and incomes to be able to purchase other food items that are not produced.

The findings from the study have important policy implications for government and other funding agencies for improving household food security status in rural Ghana. Farm households depend on own production and food purchasing to be able to remain food secure. Investments in education and improved technology are important to achieve increased production. The development of infrastructure as irrigation facilities across areas of low rainfall will go a long way to increase production in these areas.

Finally, it is recommended to undertake farm household coping strategy studies to gain insight into the process they go through towards achieving food security. The lessons learned will help address their challenges. Access to credit in relation to farm household food security status should be studied so as to better understand the dynamics of this issue.

Abbreviations

FAO: Food and Agriculture Organization; FANTA: Food and Nutrition Technical Assistance; IFAD: International Fund for Agricultural Development; UNICEF: United Nations International Children's Emergency Fund; WFP: World Food Programme; WHO: World Health Organization.

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Authors' contributions

PPA received funding, designed the research, analyzed data and drafted manuscript. EAO managed and analyzed data and reviewed literature. MO reviewed literature and reviewed manuscript. LB collected data and reviewed literature. BS reviewed literature and manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets that support findings of this study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Since the study involved human participants and researchers did not want to force anyone to participate, an informed consent note was developed and included in the survey instrument. Enumerators first introduced themselves and then explained the purpose of the research to the randomly selected participants. The consents of the participants were then requested as the total time allocated to the survey was relayed to them. They were in fact made aware that it was voluntary to participate in the survey. Prior to conducting the study, the CSIR-Crops Research Institute Internal Review committee approved the study in January 2016.

Consent for publication

All authors read and consented for the article to be published.

Competing interests

The authors declare no competing interest.

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